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National Telecommunications and
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Federal Communications Commission
Office of the Secretary

01-185

Mr. Donald Abelson
Chief, International Bureau
Federal Communications Commission
445 12th Street, S W
Washington, DC 20554

Dear Mr. Abelson:

The National Telecommunications and Information Administration (NTIA) appreciates this opportunity to review and comment on the Federal Communications Commission's (Commission) Notice of Proposed Rulemaking (NPRM) in the *Matter of Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz, the L-Band. and 1.6/2.4 GHz Band.*[1] NTIA is only addressing the interference issues and associated recommendations. We are not taking a position on any other policy issues associated with the NPRM.

In the NPRM, the Commission requests comment on proposals received from New ICO Global Communications (Holding) Ltd. (ICO), Motient Services Inc., and Mobile Satellite Ventures subsidiary (MSV) to operate ancillary terrestrial component (ATC) base station transmitters (BTS) with their networks using assigned mobile satellite service (MSS) frequencies. The BTS would operate in the 1525-1559 MHz band (MSV Proposal), or the 1990-2025 and 2165-2200 MHz bands (ICO Proposal). The BTS is to be integrated with the satellite network and will employ directional antennas that are expected to provide coverage to areas where the satellite signal is attenuated by foliage or terrain or to provide in-building coverage. In addition to the BTS, MSV will employ pico base stations that may be located on ceilings of buildings or on building walls and will use omn-directional antennas. There are also mobile terminals (MTs) that **will** be used in conjunction with the BTS and pico base stations.

In the NPRM, the Commission recognized that the unwanted emissions from terrestrial stations in the MSS will have to be carefully controlled in order to avoid interfering with GPS receivers.[2] The Commission specifically requested comments on whether limits for base stations similar to those specified in Section 25.213(b) for satellite mobile earth stations (MES) used in

1 *In the Matter of Flexibility for Delivery of Communications by Mobile Satellite service Providers in the 2 GHz, the L-Band, and 1.6/2.4 GHz Band*, IB Docket No. 01-185 (rel. Aug. 17, 2001).

2 *Id.* at ¶68.

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conjunction with the satellite are adequate to protect GPS receivers.' The frequency range over which the emission limits specified in Section 25.213(b) apply is 1574.397-1576.443 MHz. There are two issues that must be considered in the Commission's request **for** comment on the protection of GPS: 1) the frequency range over which the emission level would be applicable; and 2) whether the emission level established for a MES should be applied to a base station. Furthermore, the NPRM did not address the emission limits of the MTs used in conjunction with the BTS and pico base stations.

The frequency band 1545-1555 MHz is allocated to the aeronautical mobile satellite route service (AMS(R)S) in the space-to-Earth direction. AMS(R)S is reserved for communications relating to safety of flight (see provisions No. 1.36, 1.59, 5.357A, and Article 44 of the Radio Regulations). The frequency band 1530-1544 MHz is allocated to the Global Maritime Distress and Safety System (GMDSS) in the space-to-Earth direction. This international application is required by international treaty resulting from the Safety of Life at Sea (SOLAS) Convention. Since the BTS will have emissions that fall within the AMS(R)S and GMDSS receiver channels there is a potential for interference. However, the NPRM did not request comment on potential interference to AMS(R)S and GMDSS receivers.

To address the potential interference to GPS, AMS(R)S, and GMDSS receivers, NTIA performed three technical analyses that are provided as enclosures to this letter. Based on the results of the analysis in Enclosure 1, NTIA cannot support the Commission's proposed BTS emission levels in the GPS L1 (1559-1610 MHz), L2 (1215-1240 MHz), and L5 (1164-1188 MHz) frequency bands. Instead, NTIA recommends: 1) a maximum allowable equivalent isotropically radiated power (EIRP) of -71 dBm/MHz (wideband emissions) and -81 dBm (narrowband emissions) in the L1 frequency band; and 2) a maximum allowable EIRP of -73 dBm/MHz (wideband emissions) and -83 dBm (narrowband emissions) in the L2 and L5 frequency bands.

The Commission did not propose an emission level for the MTs used in conjunction with the BTS and pico base stations. Based on the results of the analysis in Enclosure 2, NTIA recommends: 1) a maximum allowable EIRP of -75 dBm/MHz (wideband emissions) and -85 dBm (narrowband emissions) in the L1 frequency band; and 2) a maximum allowable EIRP of -77 dBm/MHz (wideband emissions) and -87 dBm (narrowband emissions) in the L2 and L5 frequency bands.

Also, the Commission did not make a proposal for BTS adjacent channel emissions in the channels used by AMS(R)S and GMDSS receivers. Based on the results of the analysis in Enclosure 3, NTIA recommends: 1) a maximum allowable EIRP of -32.8 dBm/200 kHz per BTS carrier in the 1545-1555 portion (AMS(R)S channels) of the 1525-1559 MHz band; and 2) a maximum allowable EIRP of -22.5 dBm/200 kHz per BTS carrier in the 1530-1544 MHz portion (GMDSS channels) of the 1525-1559 MHz band,

[3] *Id*

The United States Coast Guard and the Navy expressed concern regarding aggregate interference from MTs used in conjunction with BTS to Inmarsat satellite receivers that are used to support GMDSS operations (1626.5-1645.5 MHz) and AMS(R)S operations (1646.5-1656.5 MHz). While these federal agencies do not operate the satellite transmitter, the operation of these satellite receivers is required under treaty obligations. The interference to a satellite receiver from a large number of MTs is cumulative, and will affect the uplinks from all mobile terminals located in the satellite beam, such as those used for GMDSS and AMS(R)S. Based on the analysis in Enclosure 4, operation of MTs at the EIRP level proposed by MSV co-channel with GMDSS and AMS(R)S operations should be avoided. The analysis in Enclosure 4 also shows that operation of MTs at the EIRP levels proposed by MSV on channels adjacent to GMDSS and AMS(R)S operations is feasible.

The National Oceanic and Atmospheric Administration (NOAA) operates Search and Rescue Satellite (SARSAT) Local User Terminals (LUTs) in the 1544-1545 MHz portion of the 1525-1559 MHz band. SARSAT provides distress alen and location information to appropriate public safety rescue authorities for maritime, aviation, and land users in distress. The LUTs are used to receive the information from the SARSAT satellites. NOAA currently has 14 LUTs at 7 known locations, therefore coordination with BTS operators is possible. Based on the analysis in Enclosure 5, a 30 km &stance separation between a BTS and a SARSAT LUT is necessary for compatible operation. Possible techniques to reduce the distance separation include but are not limited to: 1) reduce the BTS antenna gain in the direction of the SARSAT LUT location; 2) lower the BTS emission level in the 1544-1545 MHz portion of the 1525-1559 MHz band; and 3) take into account specific terrain features and other obstacles located between the BTS and SARSAT LUT location on a site-by-site basis.

The NTIA proposed emission levels in the GPS bands for the BTS and pico base stations are believed to be achievable with current technology since these stations can implement larger filters that will provide additional attenuation of the out-of-band emissions. The NTIA proposed reductien of the adjacent channel emissions to protect AMS(R)S and GMDSS receivers are also believed to be achievable. NTIA recognizes that the emission levels in the GPS bands for the MTs used in conjunction with the BTS and pico base stations may be difficult to achieve using current handset technology. However, the trends in handset development indicate a reduction in adjacent band and out-of-band emissions may be possible.

The calculations of maximum allowable EIRP of the BTS and pico base stations are based on a variety of assumptions, not all of which may apply in every installation. Since there are no limitations on the antenna heights for the base stations used in the system architecture proposed by MSV, the analysis results of the pico base station, which represents the limiting interference case, are used to establish the maximum allowable EIRP levels necessary for compatible operation with GPS receivers, Because installations of BTS and pico base stations must be licensed, it may be possible to include installation restrictions in the license. For example, to restrict the maximum density of BTS installations there should be a minimum separation distance between BTSs of 1 km. The license should include limitations on the minimum antenna height of the BTS and pico base stations that will assure sufficient separation from GPS receivers. Provisions should also be included in the license to restrict base station operations within 500 feet of a runway.

NTIA has obtained the views of both industry and the Federal agencies. To this end, NTIA had a number of discussions with MSV. MSV provided NTIA their analysis which was based on a 8 slot Time Division Multiple Access (TDMA) access technique that is consistent with the Global System for Mobile (GSM) communications system architecture. Their analysis also included a specific vo-coder frame occupancy rate that reduces the effective average power of the MT by the duty cycle attributed to the frame occupancy. For example, using an 8 slot TDMA system architecture, employing a quarter rate vo-coder, would reduce the effective average power (averaged over a 20 millisecond period) of an MT by 15 dB (10 Log 32). If these or similar techniques are employed, the EIRP levels specified for the MTs can be achieved.

In *summary,* NTIA has only focused on the interference issues and resolution thereof and not taken a position on any other policy issues. NTIA would appreciate an opportunity to consider our technical analysis with the Commission's staff and stands ready to support the implementation of this developing technology while ensuring the protection of GPS and other safety related systems.

Sincerelv.

Fredrick R. Wentland
Acting Associate Administrator
Office of Spectrum Management

5 Enclosures

ENCLOSURE 1

ASSESSMENT OF INTERFERENCE TO GLOBAL POSITIONING SYSTEM RECEIVERS FROM ANCILLARY TERRESTRIAL COMPONENT BASE STATIONS OPERATING IN THE 1525-1559 MHz MOBILE SATELLITE SERVICE BAND

BACKGROUND

The Federal Communications Commission (Commission) received proposals from New ICO Global Communications (Holding) Ltd. (ICO), Motient Services Inc., and Mobile Satellite Ventures Subsidiary (MSV)[1] to operate ancillary terrestrial component (ATC) base station transmitters (BTS) with their networks using assigned mobile satellite service (MSS) frequencies. The BTS would operate in the 1525-1559 MHz band (MSV Proposal)', or the 1990-2025 and 2165-2200 MHz bands (ICO Proposal). The BTS is to be integrated with the satellite network and will employ directional antennas that *are* expected to provide coverage to areas where the satellite signal is attenuated by foliage or terrain or to provide in-building coverage. In addition to the BTS, MSV will employ pico base stations that may be located on ceilings of buildings or on building walls and will use omni-directional antennas.

In response to the proposals, the Commission initiated a Notice of Proposed Rule Making (NPRM) to obtain comments on the proposals.' The 1525-1559 MHz band of operation proposed by MSV is adjacent to the 1559-1610 MHz band that **is** allocated to the radionavigation satellite service (RNSS). The RNSS systems operating in the 1559-1610 MHz band include: the Global Positioning System (GPS) L1 **signal** operating in the 1563.42-1587.42 MHz segment of the band and the Russian Federation Global Navigation Satellite System (GLONASS) operating in the 1598-1605 MHz segment of the band. GPS and GLONASS are components of the Global Navigation Satellite System (GNSS). The European Union is **also** planning to operate an RNSS system, Galileo in the 1559-1610 MHz band. It is envisioned that Galileo will also become a component of the GNSS.

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[1] MSV will provide MSS throughout North America **using** the satellites launched by Motient Services Inc. and TMI Communications and Company Limited Partnership.

[2] ***Ex parte*** letter from Lawrence H. William and Suzanne Hutchings, New ICO Global Communications (Holdings) Ltd., to Chairman Michael K. Powell, Federal Communications Commission, IB Docket **No.** 99-81 (March 8,2001); Application filed by Motient Services Inc. and Mobile Satellite Ventures Subsidiary LLC ***for*** Assignment of Licenses and **for** Authority to Launch and Operate a Next-Generation Mobile Satellite Service System (March 1,2001).

[3] *In rhe Matter of Flexibility for* ***Delivery*** *of Communications by* ***Mobile Satellite Service*** *Providers in* ***the 2*** *GHz,* ***the L-Band, and*** *1.6/2.4 GHz* ***Band.*** IB Docker No. 01-185 (rel. **Aug.** 17,2001) (hereinafter "NPRM").

At the 2000 World Radiocommunication Conference, a new allocation was adopted for the RNSS in the 1164-1215 MHz frequency band. As part of the GPS modernization program a new GPS signal for aviation and non-aviation applications designated as L5 will be provided in the 1164-1188 MHz portion of the newly allocated RNSS band. In addition to this new allocation, as part of the GPS modernization program a second signal similar to the L1 coarse/acquisition (C/A) code signal will be provided in the GPS L2 frequency band of 1215-1240 MHz.[4]

In order to completely assess compatibility of the BTS and pico base stations with the GPS service, receivers in the L1, L2, and L5 frequency bands must be analyzed.

OBJECTIVE

The objective of this analysis is to assess the potential of interference to GPS receivers operating in the L1, L2, and L5 frequency bands from the emissions of BTS and pico base stations operating in the 1525-1559 MHz band.

APPROACH

To assess the interference potential of BTS and pico base station emissions to GPS receivers, an analysis will be performed to compute the maximum allowable equivalent isotropically radiated power (EIRP) levels of the emissions in the frequency bands used by the GPS service that are necessary for compatible operation.

WIDEBAND EMISSION ANALYSIS

In the NPRM, the Commission recognized that the unwanted emissions from terrestrial stations in the MSS will have to be carefully controlled in order to avoid interfering with GPS receivers.[5] The Commission specifically requested comments on whether limits for base stations similar to those specified in Section 25.213(b) for mobile earth stations are adequate to protect GPS receivers.[6] There are two issues that must be considered in the Commission's request for comment on the protection of GPS: 1) the frequency range over which the emission level would be applicable; and 2) whether the emission level established for a mobile earth stations should be applied to a base station.

[4] The GPS Precision code (P-code) is currently transmitted in the 1215-1240 MHz band.

[5] NPRM at ¶68

[6] *Id*

The frequency range over which the emission limits specified in Section 25.213(b) apply is 1574.397-1576.443 MHz. In the current version of the SPS Signal Specification, the GPS L-band SPS ranging signal is defined as a 2.046 MHz null-to-null bandwidth signal centered on L1. The transmitted ranging signal that comprises the GPS-SPS is not limited to the null-to-null signal but extends through the band 1563.42 to 1587.42 MHz. Moreover, the Commission's request for comments only addresses the GPS system and not the other present and future components of the GNSS. **As** discussed in RTCA DO-235, the interference protection requirements for GPS and GLONASS are essentially the same.[7] **A** new RNSS system such as Galileo is expected to have similar operating characteristics as GPS, and thus will require the same protection from interference. Based on the continuing evolution of the GNSS, the maximum allowable emission level established in this analysis for BTS emissions would apply across the entire 1559-1610 MHz RNSS band. Furthermore, the Commission's request for comment on GPS protection did not include the 1164-1188 MHz and 1215-1240 MHz frequency bands.

The emission levels proposed by the Commission are an EIRP density of -70 dBW/MHz for wideband (noise-like) emissions and an EIRP of -80 dBW for narrowband (continuous wave) emissions. The emission levels are specified for mobile earth stations operating in the MSS. Since base stations and mobile stations can have different operational characteristics, the emission levels established for the MSS mobile earth stations may or may not **be** adequate to protect GPS receivers. The Commission's request for comment does not address the emission limits that are necessary for the mobile earth stations used in conjunction with the BTS and pico base stations.

This analysis considers representative base station operational scenarios in determining the maximum allowable BTS and pico base station wideband emission level that is necessary for compatibie operation with GPS receivers. The operational scenarios considered in this analysis include: 1) a terrestrial GPS receiver operating in the vicinity of a BTS and pico base station; **2)** a GPS receiver used for en-route navigation flying over multiple BTS; and **3)** a GPS receiver used for a precision approach landing operating in the vicinity of a BTS.

Terrestrial GPS Receiver Analysis

The maximum allowable EIRP of the BTS or pico base station ($EIRP_{max}$) is computed using the following equation:

$$EIRP_{max} = I_T + L_P - G_R + L_{allot} - L_{mult} + G(\theta) \qquad (1)$$

[7] Document No. **RTCA** DO-235, ***Assessment of Radio Frequency Interference Relevant to the GNSS*** **(Jan.** 27, 1997) **at F-12** (hereinafter "DO-235").

where:

I_T is the interference susceptibility threshold of the GPS receiver (dBm/MHz);
L_P is the radiowave propagation loss (dB);
G_R is the GPS receive antenna gain in the direction of the BTS/pico base station (dBi);
L_{allot} is the factor for BTS/pico base station interference allotment (dB);
L_{mult} is the factor for multiple BTS carriers (dB);
$G(\theta)$ is the reduction in BTS antenna gain in the direction of the GPS receiver (dB).

The following paragraphs explain each of the technical factors used in the analysis.

GPS Receiver Interference Susceptibility Threshold (I_T). In all GPS bands (L1, L2, and L5) the typical GPS receiver system noise density is -171 dBm/Hz for a receiver with a 3 dB noise figure. The receiver system noise density determines the minimum level of GPS signal that can be used for any application. For example, survey GPS receivers require a fairly high carrier-to-noise density ratio (C/N_0) of about 35 dB-Hz in order to provide the required level of accuracy, while wireless assisted E-911 receivers can provide adequate measurements with a very low C/N_0, such as 20 dB-Hz. Therefore, with a system noise density of –171 dBm/Hz, the survey receiver requires a minimum signal level of –136 dBm, whereas the wireless assisted E-911 receiver can function with a signal as low as –151 dBm. In either case, the receiver system noise density determines the minimum level of GPS signal that can be used for a specific application. An 'x' dB increase in the receiver noise density raises the GPS signal power requirement by the same 'x' dB. Because most terrestrial GPS receivers operate under handicaps such as signal attenuation due to destructive multipath, foliage, or walls, these receivers frequently must operate at their minimum signal levels.

Since terrestrial GPS receivers typically operate at their minimum signal levels, any interfering signal which adds to system noise density erodes performance by requiring stronger GPS signals to perform the required function. Conventional C/A code GPS receivers require a relatively high carrier-to-noise density ratio (C/N_0) because of the wide loop bandwidths that are employed. In contrast, assisted GPS receivers used in E-911 applications can take full advantage of communications network support to obtain and remove the GPS navigation data and to stabilize the receiver clock. In addition, it is assumed that the dynamics are very low (e.g., the user is walking). As a result, the tracking loop bandwidth can be narrowed very substantially, thus maintaining a positive signal-to-noise ratio in the tracking loop at much lower C/N_0 values. Receivers are being designed today that can track with a 20 dB-Hz C/N_0 and the industry is striving to track with a C/N_0 of 10 dB-Hz. Based on a system noise density of -171 dBm/Hz, a 20 dB-Hz C/N_0 represents a receiver signal level of -151 dBm (21 dB below the GPS minimum signal level in the SPS Signal Specification), and a 10 dB-Hz C/N_0 represents a received signal level of -161 dBm (31 dB below the GPS minimum signal level in the SPS Signal Specification). Regardless of the application or the minimum signal level required for that application, it is important to limit any increase in system noise. In this analysis, the increase in system noise caused by the BTS and pico base station emissions is limited to 25%, which equates to an interference-to-noise ratio (I/N) of -6 dB. Based on the I/N of -6 dB, the interference susceptibility threshold used in this analysis is -171 dBm/Hz + 60 - 6 = -117 dBm/MHz.

There are no practical differences in interference susceptibility for GPS receivers operating in any of the three bands, i.e., L1, L2, and L5. Noise interference susceptibility relates only to tolerable increase in noise floor, which for terrestrial applications is identical for all three bands. For example, noise interference susceptibility is not a function of the GPS code structure, e.g., C/A, L2C, or P(Y). It also is not a function of the code tracking technique, e.g., wide correlator, narrow correlator, double delta, multipath mitigation correlator, etc. Therefore, the interference threshold used in this analysis for all GPS bands is -117 dBm/MHz.

Radiowave Propagation Loss (L_P). Initially, the BTS will be used in urban areas where satellite signal levels are low or coverage does not exist. Urban environments can be characterized by non-line-of-sight propagation paths resulting mainly from building blockage. However, even in urban environments there are distances extending several hundred feet where line-of-sight conditions can exist. The propagation model to be used when line-of-sight conditions exist is *the* he-space model described by the following equation:

$$L_p = 20 \text{ Log } F + 20 \text{ Log } D - 27.55 \qquad (2)$$

where:

F is the frequency (MHz);

D is the distance separation between the BTS/pico base stations and the GPS receiver (m).

For the terrestrial GPS receiver analysis the distance separation between the BTS/pico base stations and GPS receiver is *the* slant range computed using the following equation:

$$D_{sep} = ((h_{GPS} - h_{BTS})^2 + D^2)^{0.5} \qquad (3)$$

where:

h_{GPS} is the height of the GPS receiver antenna (m);

h_{BTS} is the height of the BTS/pico base station antenna (m);

D is the horizontal separation between the GPS receiver and BTS/pico base station antennas (m).

The worst-case horizontal distance separation between the BTS/pico base station and GPS receiver exists at the point where the coupling loss is a minimum. The coupling loss is the combination of the propagation loss, the BTS/pico base station antenna gain in the direction of the GPS receive antenna, and GPS receive antenna gain in the direction of the BTS/pico base station. Based on the BTS antenna pattern provided by MSV[8], the GPS antenna model provided in Table 2, and using free space propagation loss, it was determined that the worst-case horizontal distance separation was 150 meters for a BTS antenna height of 30 meters, and 100 meters for a BTS antenna height of 15 meters. The antenna height of the GPS receiver was 1.5 meters. Using Equation 2 the radiowave propagation loss values used in this analysis are provided in Table 1.

Table 1.

Horizontal Distance Separation (m)	Height of BTS (m)	Height of GPS Receiver (m)	Slant Range (m)	Frequency (MHz)	Radiowave Propagation Loss (dB)
150	30	1.5	152.7	1575	80.1
150	30	1.5	152.7	1227	77.9
150	30	1.5	152.7	1176	77.5
100	15	1.5	100.9	1575	76.5
100	15	1.5	100.9	1227	74.3
100	15	1.5	100.9	1176	73.9

In the analysis of pico base stations the antenna heights of the pico base station and GPS receiver are 5 meters and 1.5 meters respectively. The horizontal distance separation between the GPS receiver and the pico base station is 5 meters. Using Equation 3, the minimum distance separation is:

$$D_{sep} = ((5 - 1.5)^2 + 5^2)^{0.5} = 6.1 \text{ m}$$

Using Equation 2, the radiowave propagation loss values for the L1, L2, and L5 bands are: 52.1 dB (L1), 50 dB (L2), and 49.6 dB (L5).

GPS Receive Antenna Gain (G_R). The GPS receive antenna gain model used in this analysis is provided in Table 2. The antenna gain used in this analysis is based on the position of the BTS/pico base station with respect to the GPS receive antenna, which is determined from the antenna heights of the BTS/pico base station and GPS receiver and the horizontal separation distance.

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[8] Mobile Satellite Ventures LP, *Out-of-Band Emissions of MSV's Ancillary Terrestrial Base Stations Relative to the GPS Band* (Feb. 25, 2002) at 5 (hereinafter "MSV Analysis").

Off-Axis Angle (Measured with Respect to the Horizon)	GPS Antenna Gain (dBi)
-90 degrees to -10 degrees	-4.5
- 10 degrees *to* 10 degrees	0
10 degrees to 90 degrees	3

The off-axis angle measured with respect to the horizon for antennas heights of 1.5 meters and 30 meters for the GPS receiver and BTS and the minimum separation distance of 150 meters is 10.8 degrees. From Table 2 the corresponding GPS receive antenna gain in the direction of the BTS used in this analysis is **3** dBi. The off-axis angle measured with respect to the horizon for antennas heights of 1.5 meters and 15 meters for the GPS receiver and BTS and the minimum separation distance of 100 meters is 7.7 degrees. From Table 2 the corresponding GPS receive antenna gain in the direction of the BTS used in this analysis is 0 dBi.

The off-axis angle for the antenna heights of 1.5 meters and 5 meters for the GPS receiver and the pico base station and the horizontal separation distance of 5 meters is 35 degrees. From Table 2, the corresponding GPS receive antenna gain in the direction of the pico base station used in this analysis is *3* dBi.

BTS Interference **Allotment (L_{allot}).** The Commission's rules permit adjacent band MSS earth terminals, 700 MHz public safety mobile and portable transmitters, and 700 MHz commercial mobile transmitters to operate with allowable emission levels of -70 dBW/MHz (EIRP) in the 1559 1610 MHz frequency band. There is also another proposal for operating ancillary base stations by ICO in the 2 GHz frequency range. To take into account that at least one of these other potential interfering sources could be operating in the vicinity of the GPS terrestrial receiver, 50% of the total interference budget is allotted to the emissions from a BTS or pico base station. **A** 50% interference allotment equates to a **3** dB reduction in the maximum allowable emissions from the **BTS** and pico base stations (e.g., 10 Log 0.5).[9]

Multiple **BTS** Carriers (L_{mult}). The antenna for the BTS is divided into three sectors. Within each sector there **are** three separate carrier signals. **A** terrestrial GPS receiver will only be in view of one of the three sectors. To take into account the multiple carrier signals in each sector a factor of 10 Log(3) **or** 4.8 dB is included in the analysis. Since the pico base stations are not transmitting multiple carriers, this factor is not applicable.

[9] The coverage area of a BTS is expected to be on the order of 1 kilometer. Therefore interference from multiple BTS of the same network to a terrestrial CPS receiver **was** not considered.

BTS Antenna Gain Reduction ($G(\theta)$). The antenna pattern provided by MSV **was** used to determine the reduction in the BTS antenna gain in the direction of the GPS receiver. The BTS antenna **has** a **5** degree tilt down angle.[10] Table 3 provides the elevation angle to the BTS **from** the GPS receive antenna, **off-axis** angle adjusted for the tilt down angle, and the reduction of the BTS antenna gain that are used in this analysis.

Distance Separation (m)	Height of BTS (m)	Height of GPS Receiver (m)	Elevation Angle (Deg)	Off-Axis Angle (Deg)	Reduction of BTS Antenna Gain in the Direction of GPS Receiver (dB)
150	30	1.5	10.8	5.8	3
100	15	1.5	1.7	2.7	0.5

The pico base stations employ omni-directional antennas, therefore no reduction in antenna gain is necessary.

Parameter	Value		
	L1	**L2**	**L5**
GPS Receiver Interference Susceptibility Level (dBm/MHz)	-117	-117	-117
Radiowave Propagation Loss (dB)	80.1	77.9	77.5
GPS Receive Antenna Gain (dBi)	-3	-3	-3
BTS Interference Allotment (dB)	-3	-3	-3
Multiple BTS Carriers (dB)	4.8	4.8	4.8
BTS Antenna Gain Reduction (dB)	3	3	3
Maximum Allowable EIRP (dBm/MHz)	44.7	46.9	47.3

[10] MSV Analysis at 3

Parameter	Value		
	L1	**L2**	**L5**
GPS Receiver Interference Susceptibility Level **(dBm/MHz)**	-117	-117	-117
Radiowave Propagation Loss (dB)	76.5	14.3	73.9
GPS Receive Antenna Gain (dBi)	0	0	0
BTS Interference Allotment (dB)	-3	-3	**-3**
Multiple BTS Carriers (dB)	4.8	-4.8	-4.8
BTS Antenna Gain Reduction (dB)	**0.5**	0.5	0.5
Maximum Allowable **EIRP (dBm/MHz)**	-47.8	-50	-50.4

The maximum allowable EIRP of the pico base station emissions in the L1, L2, and L5 frequency bands that are necessary for compatible operation with terrestrial GPS receivers are given in Table *6***.**

Parameter	Value		
	L1	**L2**	L5
GPS Receiver Interference Susceptibility Level **(dBm/MHz)**	-117	-117	-117
Radiowave Propagation Loss (dB)	**52.1**	SO	49.6
GPS Receive Antenna Gain (dBi)	-3	-3	-3
BTS Interference Allotment (dB)	-3	-3	**-3**
Maximum Allowable **EIRP** (dBm/MHz)	-70.9	-73	-73.4

The preceding calculations of maximum allowable EIRP of the BTS and pico base stations are based on a variety of assumptions, not all of which may apply in every installation. For example, a BTS could be installed on a tall building at a height of 30 meters, and GPS users could be in that building or on an observation deck in direct line of sight of the BTS antenna. **A** pico base station could be installed at the ceiling of a large hotel ballroom, and GPS users could be on the floorjust above that installation. In addition, although it is **unlikely,** it would be undesirable to have a **high BTS** installation density within a metropolitan area or near aviation corridors. Because installations of BTS and pico base stations must be licensed, it may be possible to include installation restrictions in the license. For example, to restrict the maximum density of BTS installations there could be a minimum separation distance between BTS of 1 km. The license could also include limitations on the minimum antenna height of the BTS and pico base stations that will assure sufficient separation from GPS receivers.

Aviation **GPS** Receiver Analysis

Two operational scenarios are considered for the **examining** compatibility between BTS and aviation GPS receivers: 1) the total number of active BTS that are necessary to exceed the aviation receiver interference susceptibility threshold; and **2)** a single BTS located in the vicinity of a runway. Since the pico base stations will be employed indoors and in areas where building blockage is high they are not expected to be the limiting interference case and therefore, are not considered in this analysis.

Operational Scenario 1

In this analysis a GPS receiver used onboard an en-route aircraft at an altitude of 1000 feet (300 meters) is considered.[11] The received interference power level is computed using the EIRP level proposed by MSV for the BTS and *the* antenna gain characteristics of the BTS provided by MSV. The computed received interference power level is then compared to the GPS receiver interference susceptibility threshold to determine the amount of available margin. Based on the available margin, the number of BTS that can be operating simultaneously before the interference susceptibility threshold is exceeded is determined.

The received interference power level is computed using Equation 4.

$$I = EIRP + G_R - L_P + L_{safety} - G(\theta) - L_{allot} - L_B \tag{4}$$

where:

I is the interference power level at the input of the GPS receiver (dBm/MHz);
$EIRP$ **is** the EIRP density of the BTS (dBm/MHz);
G_R is the GPS receive antenna gain in the direction of the BTS (dBi);
L_p is the radiowave propagation loss between the BTS and the GPS receiver **(dB);**
L_{safety} **is** the aviation safety margin (dB);
$G(\theta)$ is *the* reduction in BTS antenna gain in the direction of the GPS receiver (dB);
L_{allot} is the factor for BTS interference allotment (dB);
L_B is the loss due to building blockage **(dB).**

The difference between the interference susceptibility threshold (I_T) and the received interference power level computed using Equation **4,** represents the available margin (M_{avail}).

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[11] **Document No. RTCA DO-235,** Assessment of Radio Frequency **Interference Relevant to** the GNSS (Jan 27, 1997) at A-2.

The number of BTS (N_{BTS}) that would have to be simultaneously transmitting before the interference susceptibility threshold is exceeded is determined by:

$$N_{BTS} = 10^{M_{avail}/10}$$

It is expected that based on the central limit theorem, if there are a large number of BTS signals the GPS receiver would actually see an aggregate signal producing a noise-like interference effect in the receiver.

The following paragraphs explain each of factors used in the analysis

BTS EIRP. The EIRP density for the BTS emissions used in this analysis is -40 dBm/MHz as proposed in the NPRM.[12]

GPS Receive Antenna Gain (G_R). During en-route navigation, the GPS receiver is located on top of the aircraft. In a previous analysis of terrestrial interference to GPS receivers used for aviation applications, an antenna gain below the aircraft of -10 dBi was used.[13] Since there are no specifications on antenna gain below the aircraft and sufficient installed antenna pattern data is lacking on civil aircraft the value of antenna gain of -10 dBi is used in this analysis. The antenna gain used in this analysis assumes a constant antenna gain in the region below the aircraft, the actual antenna pattern contains many peaks and nulls (maximum and minimum values of antenna gain).[14] Therefore this antenna gain represents a conservative estimate of the received interference power level.

Radiowave Propagation Loss (L_P). Line-of-sight conditions will exist between the airborne GPS receive antenna and the BTS. The freespace propagation model described in Equation 2 is used to compute the radiowave propagation loss. In this analysis an antenna height of 30 meters is used for the BTS. The minimum distance separation between the BTS and aircraft is 270 meters (300 meters - 30 meters). Using Equation 2, the radiowave propagation loss for the two frequency bands to be used by GPS aviation receivers is:

$$L_P = 20 \text{ Log } (1575) + 20 \text{ Log } (270) - 27.55 = 63.9 + 48.6 - 27.55 = 84.9 \text{ dB} \quad \text{(L1)}$$

$$L_P = 20 \text{ Log } (1176) + 20 \text{ Log } (270) - 27.55 = 61.4 + 48.6 - 27.55 = 82.5 \text{ dB} \quad \text{(L5)}$$

[12] NPRM at ¶68.

[13] RTCA DO-235 at F-13.

[14] *Id.* at Appendix E Annex 2.

Aviation Safety Margin (L_{safety}). When using a GPS receiver for en-route navigation, it is appropriate to include a safety margin. The aviation safety margin is used to account for uncertainties on the aviation side of the link budget that are real but not quantifiable. These include but are not limited to: multipath of the GPS signal; receiver implementation losses; antenna gain variations; and approach path deviation. Since the GPS signal level cannot be increased, the aviation safety margin is implemented by lowering the allowable interference. A safety margin of *6* dB is included in the analysis for GPS receivers used in aviation applications. The aviation safety margin of *6* dB included in this analysis is consistent with the value specified in ITU-R Recommendation M.1477.[15]

BTS Antenna Gain Reduction (G(θ)). The antenna pattern provided by MSV was used to determine the off-axis reduction in the BTS antenna gain in the direction of the GPS receiver. The aircraft is assumed to be overhead of the ground-based BTS with an off-axis angle of 90 degrees. The minimum antenna gain reduction relative to the peak for off-axis angles above 30 degrees is approximately 30 dB.[16]

BTS Interference Allotment (L_{allot}). In addition to the potential interference from BTS emissions, several other potential sources of interference to GPS aviation receivers have been identified. These potential sources of interference include but are not limited to: 1) adjacent band interference from MSS handsets; 2) harmonics from television transmitters; 3) adjacent band interference from super geostationary earth-orbiting (super GEO) satellite transmitters"; 4) spurious emissions from 700 MHz public safety base, mobile, and portable transmitters; and 5) spurious emissions including harmonics from 700 MHz commercial base, mobile, and portable transmitters. Multiple sources of interference, which might individually be tolerated by a GPS receiver, may combine to create an aggregate interference level (e.g., noise and emissions) that could prevent the reliable reception of the GPS signal. In this analysis, a percentage of the total allotment is attributed to BTS emissions. For the en-route operational scenario, larger geographic areas are visible to a GPS receiver onboard an aircraft at altitude. This larger field of view will increase the number of interfering sources that can contribute to the total interference level at the receiver. In *this* analysis, 25% of the total interference budget is allotted to BTS emissions. The factor for BTS interference allotment is computed from 10 Log (BTS interference allotment ratio). For the BTS interference allotment of *25%* (a ratio of 0.25), a *6* dB factor *is* included in the analysis.

[15] ITU-R M.1477 at Annex 5.

[16] MSV Analysis at 3.

[17] Super GEOs are geostationary earth orbiting satellites that are designed to employ a high transmit power to communicate with mobile handsets.

Building Blockage Loss (L_B). In a large geographic area there will be a percentage of the BTS that have an obstructed view of the airborne GPS receiver resulting from building blockage. The following equation is used to compute the reduction in the aggregate interfering signal level at the airborne receiver taking building blockage into account:

$$L_B = 10 \text{ Log } (P_O/(10^{Lba/10}) + P_U) \qquad (5)$$

where:

L_B is the building blockage loss (dB);
P_O is the percentage of BTS that are obstructed;
P_U is the percentage of the BTS that are unobstructed;
Lba is average building attenuation loss (dB).

In this assessment 50% of the BTS are assumed to have an obstructed view of the airborne GPS receiver. An average value of 9 dB is used for the building attenuation loss for the obstructed BTS.[18] Using Equation 5, this results in a 2.5 dB reduction of the aggregate interfering signal level at the input of the airborne receiver.

GPS Receiver Interference Susceptibility Threshold (I_T). For in-band broadband noise interference, both the RTCA and ITU-R limits are -116.5 dBm/MHz for GPS L1 aviation receivers when operating in the acquisition mode.[19]

The interference susceptibility threshold for GPS receivers using the L5 signal has not been finalized. In this analysis the interference susceptibility threshold for GPS receivers using the L1 signal of -116.5 dBm/MHz is used.

Analysis Results. Based on the BTS EIRP level proposed by MSV, the maximum number of BTS simultaneously transmitting before the GPS aviation receiver interference susceptibility threshold is exceeded is given in Table 7. Using the maximum allowable EIRP computed for compatible operation in the previous section (Table 4), the maximum number of BTS simultaneously operating before the GPS aviation receiver interference susceptibility threshold is exceeded is given in Table 8.

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[18] NTIA Report 95-325, Building Penetration Measurements From Low-height **Base Stations at 912, 1920, and** 5990 MHz, National Telecommunications and Information Administration, Institute for Telecommunication Sciences (Sept. 1995).

[19] RTCA DO-229B at 38; ITU-R M. 1477 at Table 1.

Parameter	Value	
	L1	L5
BTS EIRP (dBm/MHz)	-40	-40
GPS Receive Antenna Gain (dBi)	-10	-10
Radiowave Propagation Loss (dB)	-84.9	-82.5
Aviation Safety Margin (dB)	6	6
BTS Antenna Gain Reduction (dB)	-30	-30
BTS Interference Allotment (dB)	6	6
Building Blockage Loss (dB)	-2.5	-2.5
Interference Power Level (dBm/MHz)	-155.4	-153
GPS Receiver Interference Susceptibility Level (dBm/MHz)	-116.5	-116.5
Available Margin (dB)	38.9	36.5
Number of Active BTS	7763/9 = 863	4467/9 = 496

Parameter	Value	
	L1	L5
BTS EIRP (dBm/MHz)	-44.7	-47.3
GPS Receive Antenna Gain (dBi)	-10	-10
Radiowave Propagation Loss (dB)	-84.9	-82.5
Aviation Safety Margin (dB)	6	6
BTS Antenna Gain Reduction (dB)	-30	-30
BTS Interference Allotment (dB)	6	6
Building Blockage Loss (dB)	-2.5	-2.5
Interference Power Level (dBm/MHz)	-160.1	-160.3
GPS Receiver Interference Susceptibility Level (dBm/MHz)	-116.5	-116.5
Available Margin (dB)	43.6	43.8
Number of Active BTS	23909/9 = 2545	23988/9 = 2665

The number of active BTS shown in Table 7 and 8 are divided by 9 to take into account the 3 sector antenna for each BTS **with 3** carrier signals in each sector resulting in a total of 9 carrier frequencies for each BTS.

At *this* time it is extremely difficult to estimate the density of BTS operating in a geographic **area**. However, the small BTS range of 1 km indicates that, in order to provide adequate coverage in **an urban** area, the BTS may be densely spaced. The line-of-sight distance from **an** aircraft at an altitude of 1000 feet is approximately 73 km. Therefore, if the density of BTS is high, the number that are in view of an aircraft can be quite large.

The calculations shown in Table 7, that are based on the **EIRP** level proposed in the NPRM, indicate that it only requires a moderate number of BTS to exceed the GPS receiver interference susceptibility threshold. However, when the EIRP values computed for compatible operation with non-aviation GPS receivers are considered, the maximum allowable number of BTS approaches a number more representative of BTS density in an urban area.

Operational Scenario **2**

In this analysis the BTS is located 500 feet from the runway where a GPS equipped aircraft is making a precision approach landing.

The maximum allowable EIRP of the BTS ($EIRP_{max}$) is computed using the following equation:

$$EIRP_{max} = I_T + L_P - G_R - L_{allot} - L_{mult} + G(\theta) - L_{safety} \qquad (5)$$

where:

I_T is the interference susceptibility threshold of the GPS receiver (dBm/MHz);
L_P is the radiowave propagation loss (dB);
G_R is the GPS receive antenna gain in the direction *of* the BTS (dBi);
L_{allot} is the factor for BTS interference allotment (dB);
L_{mult} is the factor for multiple BTS carriers (dB);
$G(\theta)$ is the reduction in BTS antenna gain in the direction of the GPS receiver (dB);
L_{safety} is the aviation safety margin (dB).

The following paragraphs explain each of the technical factors used in the analysis.

GPS Receiver Interference Susceptibility Threshold (I_T). For in-band broadband noise interference, both the RTCA and ITU-R limits are -110.5 dBm/MHz for GPS L1 aviation receivers when operating in the tracking mode.[20]

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[20] **RTCA DO-229B at 38.**

The interference susceptibility threshold for GPS receivers using the L5 signal has not been finalized. In this *analysis* the interference susceptibility threshold for GPS receivers using the L1 signal of -110.5 dBm/MHz is used.

Radiowave Propagation Loss (L_P). Line-of-sight conditions will exist between the airborne GPS receive antenna and the BTS. The freespace propagation model described in Equation 2 is used to compute the radiowave propagation loss. The separation distance between the BTS and aircraft is 150 meters. Using Equation **2,** the radiowave propagation loss for the two frequency bands to be used by GPS aviation receivers is:

$$L_P = 20 \text{ Log } (1575) + 20 \text{ Log } (150) - 27.55 = 63.9 + 43.5 - 27.55 = 79.9 \text{ dB} \qquad \text{(L1)}$$

$$L_P = 20 \text{ Log } (1176) + 20 \text{ Log } (150) - 27.55 = 61.4 + 43.5 - 27.55 = 77.4 \text{ dB} \qquad \text{(L5)}$$

GPS Receive Antenna Gain (G_R). For GPS aviation receive antennas, the **minimum** antenna gain at 5 degrees elevation is **-4.5** dBi.[21]

BTS Interference Allotment (L_{allot}). **As** discussed in the Operational Scenario I analysis, a 25% interference allotment which equates to a 6 dB reduction in the maximum allowable emissions from the BTS is used in this analysis.

Multiple BTS Carriers (L_{mult}). The antenna for the BTS is divided into three sectors. Within each sector there are three separate carrier signals. ***An*** aviation GPS receiver will only be in view of one of the three sectors. To take into account the multiple carrier signals in each sector a factor of 10 Log(3) or 4.8 dB is included in the analysis.

BTS Antenna Gain Reduction ($G(\theta)$). The antenna pattern provided by MSV was used to determine the reduction in the BTS antenna gain in the direction of the GPS receiver. The BTS antenna has a **5** degree tilt down angle.[22] The BTS antenna height is the same as the aircraft height at the Category II/III decision height of 100 feet (30 meters). The angle used to determine the reduction of the BTS antenna gain is tilt down angle of 5 degrees. For a 5 degree angle the reduction of the BTS antenna gain in the direction of the GPS aviation receiver is 2 dB.

Aviation Safety Margin (L_{safety}). When using a GPS receiver for precision approach landings it is appropriate to include **a** safety margin. **As** discussed in the Operational Scenario 1 analysis, the aviation safety margin is 6 dB.

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[21] Document No. RTCA DO-228. ***Minimum Operational Performance Standards for Global Navigation Satellite System (GNSS) Airborne Antenna Equipment*** (Oct. *20,* 1995) **at 6.**

[22] **MSV Analysis at 3.**

Analysis Results. The **maximum** allowable EIRP of the BTS emissions in the L1 and L5 kequency bands that are necessary for compatible operation with aviation GPS receivers are given in Table 9.

Parameter	**Value**	
GPS Receiver Interference Susceptibility Level (dBm/MHz)	-110.5	**-1105**
Radiowave Propagation Loss (dB)	**79.9**	**71.4**
GPS Receive Antenna Gain (dBi)	**4.5**	**4.5**
BTS Interference Allotment (dB)	**-6**	**-6**
Multiple BTS Carriers (dB)	**4.8**	**-4.8**
BTS Antenna Gain Reduction (dB)	2	2
Aviation Safety Margin (dB)	**-6**	-6
Maximum Allowable EIRP (dBm/MHz)	**-40.9**	**-43.4**

NARROWBAND EMISSIONS

The NPRM acknowledges that a narrowband emission limit is necessary to protect **GPS** receivers.[23] The exact impact of interference to a GPS receiver is primarily dependent on the type of interference. GPS receivers using the C/A code are known to be susceptible to narrowband interference primarily because of the relatively short period of the C/A code.[24] With a period of 1 millisecond, the C/A code spectrum is not continuous, but rather it is a line spectrum with discrete lines at 1 kHz intervals. In addition, there are some "strong lines" in each C/A code that can deviate significantly from a $[\sin(x)/x]^2$ envelope. This makes a C/A code receiver vulnerable to continuous wave (CW) or very narrowband interfering signals since they can mix with a strong C/A code line and affect the code and carrier tracking loops.

The narrow band out-of-band emissions from BTS and pico base stations may be CW if they are synthesizer spun or they may be modulation artifacts having somewhat wider bandwidths. Since some spectral lines can be as much as 10 dB higher than the $[\sin(x)/x]^2$ envelope, the susceptibility of the C/A code structure to extremely narrowband interference can

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[23] NPRM at ¶68.

[24] RTCA **DO-235 at** C-4.

increase by approximately 10 dB.[25] **This** means that the power of **a** narrowband interfering signal must be 10 dB lower than that **of** a wide band interfering signal to protect **GPS** receivers.

OTHER INTERFERENCE ISSUES

Intermodulation Interference. Intermodulation occurs due to interaction (mixing) between two or more different carrier frequencies. This mixing can take place in a transmitter or receiver or external to both devices. **As** the number of transmitters at a base station site is increased, the probability of generating **an** intermodulation product that can fall in the receiver passband increases accordingly. Each BTS will have 9 carrier frequencies, which could result in intermodulation products being generated that fall in the passband of GPS receivers. The maximum allowable emission limits will apply to all unwanted emissions including intermodulation products.

INTERFERENCE MITIGATION TECHNIQUES

The analysis provided by MSV included several factors that would mitigate interference to GPS receivers. If it is possible to include a requirement for these interference mitigation techniques in the service rules adopted for BTS and pico base stations, the maximum allowable EIRP levels could be increased accordingly.

MEASUREMENT TECHNIQUES

The wideband emission level is to be measured using **an** root-mean-square (RMS) detection scheme. The measurements are to be made with a minimum resolution bandwidth of 1 MHz and the video bandwidth is not be less than the resolution bandwidth. The measurements are to be made over a **20** millisecond averaging period. The BTS must be transmitting data throughout the averaging period.

The narrowband emission level is *to* be measured using a RMS detection scheme. The measurements are to be made with a resolution bandwidth of no less than 1 kHz. The measurements are to be made over a 20 millisecond averaging period. The BTS must be transmitting data throughout the averaging period.

CONCLUSIONS

The calculations of maximum allowable EIRP of the BTS and pico base stations are based on a variety of assumptions, not all ***of*** which may apply in every installation. Since there

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[25] **Christopher** J. **Hegarty,** ***Analytical Derivation of Maximum Tolerable In-Band Interference Levels for Aviation Applications of GNSS***, Journal of the Institute of Navigation, Vol. **44,** No. **1 (March 1997).**

are no limitations on the antenna heights for the base stations used in the system architecture proposed by MSV, the analysis results of the pico base station, which represents the limiting interference case, are used to establish the maximum allowable EIRP levels necessary for compatible operation with GPS receivers. Because installations of BTS and pico base stations must be licensed, it may be possible to include installation restrictions in the license. For example, to restrict the maximum density of BTS installations there should be a minimum separation distance between BTS of 1 km. The license should include limitations on the minimum antenna height of the BTS and pico base stations that will assure sufficient separation from GPS receivers. Provisions should also be included in the license to restrict base station operations within 500 feet of an airport runway.

In the 1559-1610 MHz band for wideband base station emissions the maximum allowable EIRP for compatible operation is -71 dBm/MHz (Table 6). For narrowband emissions, the EIRP is 10 dB lower than the level for wideband emissions, resulting in a maximum allowable EIRP of -81 dBm for narrowband base station emissions. These emission limits apply to all unwanted emissions including intermodulation products.

In the 1215-1240 MHz band for wideband base station emissions the maximum allowable EIRP for compatible operation is -73 dBm/MHz (Table 6). For narrowband emissions, the EIRP is 10 dB lower than the level for wideband emissions, resulting in a maximum allowable EIRP of -83 dBm for narrowband base station emissions. These emission limits apply to all unwanted emissions including intermodulation products.

In the 1164-1188 MHz band for wideband base station emissions the maximum allowable EIRP for compatible operation is -73 dBm/MHz (Table 6). For narrowband emissions, the EIRP is 10 dB lower than the level for wideband emissions, resulting in a maximum allowable EIRP of -83 dBm for narrowband base station emissions. These emission limits apply to all unwanted emissions including intermodulation products.

ENCLOSURE 2

ASSESSMENT OF INTERFERENCE TO GLOBAL POSITIONING SYSTEM RECEIVERS FROM ANCILLARY TERRESTRIAL COMPONENT MOBILE TERMINALS OPERATING IN MOBILE SATELLITE SERVICE BANDS

BACKGROUND

The Federal Communications Commission (Commission) received proposals from New ICO Global Communications (Holding) Ltd. (ICO), Motient Services Inc., and Mobile Satellite Ventures Subsidiary (MSV)[1] to operate ancillary terrestrial component (ATC) base station transmitters (BTS) with their networks using assigned mobile satellite service (MSS) frequencies. The BTS would operate in the 1525-1559 MHz band (MSV **Proposal)**[2], or the 1990-2025 and 2165-2200 MHz bands (ICO Proposal). The BTS is to be integrated with the satellite network and will employ directional antennas. In addition to the BTS, MSV will employ pico base stations operating in the 1525-1559 MHz band that may be located on ceilings of buildings or on building walls and will use omni-directional antennas. The mobile terminals (MTs) that are used in conjunction with the BTS and pico base stations operate in the 1626-1660.5 MHz band.

In response to the proposals, the Commission initiated a Notice of Proposed Rule Making (NPRM) to obtain comments on the proposals.[3] In the NPRM, the Commission recognized that the unwanted emissions from terrestrial stations in the MSS will have to be carefully controlled in order to avoid interfering with GPS receivers.[4] The Commission specifically requested comments on whether limits for base stations similar to those specified in Section 25.213(b) for mobile earth stations are adequate to protect GPS receivers.[5] However, the NPRM does not address the emission limits of the ATC MTs that are operating in conjunction with the BTS. It

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[1] MSV will provide MSS throughout North America using the satellites launched by Mohent Services Inc. and TMI Communications and Company Limited Partnership.

[2] *Ex pane* letter from Lawrence H. Williams and Suzanne Hutchings, New ICO Global Communications (Holdings) Ltd., to Chairman Michael K. Powell, Federal Communications Commission. IB Docker No. 99-81 (March 8, 2001); Application filed by Motient Services Inc. and Mobile Satellite Ventures Subsidiary LLC for Assignment of Licenses and for Authority io Launch and Operate a Next-Generation Mobile Satellite Service System (March I, 2001).

[3] *In the Matter of Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz, the L-Band, and 1.6/2.4 GHz Band*, IB Docket No. 01-185 (rel. Aug. 17, 2001) (hereinafter "NPRM").

[4] NPRM at ¶68

[5] *Id*